Historic, Archive Document

Do not assume content reflects current scientific knowledge, policies, or practices

LIBRARY OF
RECORD
APR 9 1944
SOURCE

MAINE AGRICULTURAL EXPERIMENT STATION.

BULLETIN No. 4.

SECOND SERIES.

TESTING CREAM AND MILK FAT TEST AND LACTOMETER.

J. M. Bartlett.

Notes on Testing Cream.

As many creameries are adopting the fat test as a measure by which to pay for their cream, it is of the utmost importance that the samples for the test should be properly taken. Cream from a herd of several cows raised at the proper temperature and skimmed in a proper manner will not vary much in butter fat from day to day, but all patrons are not sufficiently careful in skimming and handling their cream so that it is subject to no small amount of variation, causing the creamery man considerable trouble.

The skimming should never be done by dipping the cream from the top of the milk, as this method always involves a loss of both cream and skimmed milk. The loss of cream is from its being mixed with the milk by the dipping and the loss of milk to the farmer is by a large amount being taken up with the cream in an effort to secure all the cream. This milk is taken to the factory and is a total loss to the farmer. The skimming should be done as cleanly as possible and this is best accomplished by a faucet near the bottom of the can. The next best thing is a syphon by means of which the milk or cream can be drawn off separately.

The above mentioned difficulties to the creamery managers, however, can be wholly overcome by the composite sample, first recommended for milk by Prof. Patrick, of the Iowa Experiment Station. There are several ways of taking this sample. One is to provide the collector with a measuring can and a small can marked with the patron's name or number in which to put the sample. The cream is measured, then thoroughly mixed and a portion taken out, put in the sample can and sealed. The amount taken should be an aliquot part of the whole.

If need be the small can may be spaced or marked, as some dealers in dairy supplies have suggested, the same as the measuring can. Then as many spaces or inches of cream can be put in the sample can as there are in the measuring can. Such samples are taken every time a patron's cream is collected, sent to the factory, put in another can or jar marked with the patron's name and kept in an ice chest until the test is made. This constitutes the composite sample which, when tested at the end of one or two weeks as desired, will show accurately the per centage of fat in the patron's cream for that period. With this per centage and the weight of cream furnished, the exact number of pounds of butter fat supplied by this patron can be calculated.

Another method of taking the sample is to bring the cream of each patron to the factory in a can by itself and then take the sample. This involves having a large number of cans for collecting and in some cases is not practical, but on the other hand the man that makes the test has an opportunity to see that the sample is properly taken.

In some cases it is desirable to defer testing for quite a time and the portion of cream reserved for the test becomes sour and curdled. When in this condition it is best brought into shape for measuring in the pipette by the method suggested by Mr. E. H. Farrington, Illinois Station, for handling sour milk, which is, to add to the sample a small amount of "Concentrated Lye" (caustic soda) in powder, about one-half teaspoonful to a pint of cream and heat to about 110° to 125° F, shake thoroughly and allow to cool, when it will be found in as good condition to measure as when fresh.

In regard to apportioning the proceeds, or paying by the test, we will simply repeat what was said in a previous bulletin, that we think it better not to calculate the fat to butter, but allow each patron such a share of the butter made for a given period as the amount of fat he furnished shows he is entitled to receive.

For instance, suppose that a creamery makes 10,000 pounds of butter in a week and receives from its patrons 8,200 pounds butter fat according to test. Mr. A. furnished 82 pounds of that butter fat; then he is entitled to one hundredth of 10,000 or 100 pounds of butter. Butter ordinarily contains from 79 to 87 per cent. butter fat; a correct average, therefore, would be about 83 per cent. for those parties who find it more convenient to calculate the fat over to butter.

In Bulletin No. 3, of this Station, two formsof cream bottles are described. The one designated as cream bottle No. 2, graduated to read to 25 per cent. fat, was at that time recommended for use in testing cream raised by the cold deep setting process in preference to the bottle with a separable neck, which is shown by the accompanying cut and designated as test bottle No. 3. Since that time the writer has made many tests with bottle No. 3, and prefers it in many respects to any other form for the following reasons:

1st. The base is the portion most liable to break and is comparatively inexpensive.

2nd. A large number of the bases can be had at small cost, allowing samples to be measured out and put away to test at some more convenient time. Only one set of the more costly graduated necks are needed to carry on the work.

3rd. The fat can be measured more accurately as all the bottles are set in a tank of water heated to 110 to 120 Fah., and the per cent. of fat is read at a uniform temperature.

4th. Because cream very rich in fat can be tested.

Method of Working with This Bottle. Measure 18c. c. of cream into the base portion of the bottle in the manner given in the directions for measuring milk. Then measure in about 18c. c. of sulphuric acids spe. grav. 1.82–1.83, thoroughly mix the acid with the cream, place the bottle, without the neck, in the centrifugal machine and whirl five minutes at the rate of 800 to 900 revolutions per minute, then fill nearly full with hot water and whirl for two minutes more to bring the fat on top the water, remove from the machine without shaking, and connect the base with the graduated neck by means of a short rubber tube supplied for the purpose, and stand in a small tank filled with water heated to 110 to 120 F. The tank must be deep enough to allow the water to come up within an inch or two of the top of the neck. The fat is now raised into the neck by filling the bottle to the 33 or 34 mark with a hot mixture of acid and water, one part acid to two of water. In making this mixture the acid should always be poured into the water, and if used immediately no heating will be required. In five to ten minutes after the neck is filled the fat will have risen in a solid column and the percentage may be read the same as in case of milk bottles.

It will sometimes be noticed that in adding water to the bottles after the first whirling the fat is not clear and yellow, but light colored and muddy. This latter condition is usually caused by too little acid being used, and can be remedied by adding a little more acid, shaking and whirling the bottle again. If the fat has curd mixed with it the reading will be too high.

In ordering the bottles described above, parties should be particular to state that "cream bottle No. 3" is wanted.

We would not advise getting larger than a twenty bottle machine, and we would order two dozen graduated necks and four or five dozen bases for a machine of that size. Dealers furnishing these bottles should always fit them with the piece of rubber tubing to connect the base with the neck.

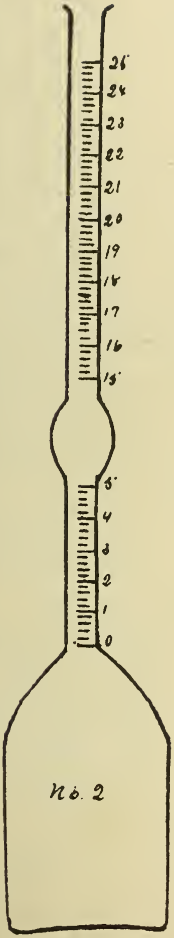
A very convenient way of handling the acid, is to have a glass stoppered burette holding three or four charges, so fastened to a shelf or stand that it can be filled by a glass stoppered syphon passing into a large acid bottle above.

This syphon is filled with acid by blowing into the bottle through a small piece of rubber tubing connected with a piece of glass tubing passing through the stopper which should fit the acid bottle perfectly.

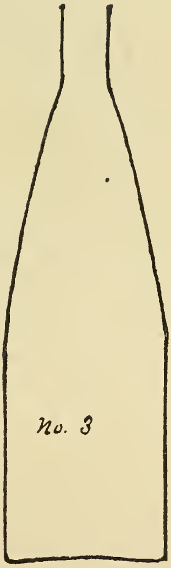
This piece of apparatus with a gallon bottle can be supplied by glass dealers for about $4.00.

For filling the bottles with hot water, we would recommend a galvanized iron tank placed above the centrifugal machine, with a faucet near the bottom to which is attached a piece of rubber tubing three feet long with a glass nozzle which can be moved around to each of the bottles where they stand in the machine.

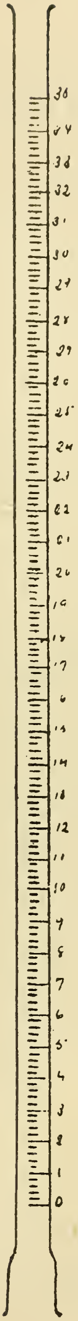
Note. The writer has designed a bottle for determining the fat in butter made similar to No. 3, except the middle portion of the neck is enlarged like a pipette. The small portions above and below the enlargement are graduated the same as the milk bottles. The range of readings is from 70 to 90 per cent. fat using 18 grams of butter. The efficiency of this bottle has not yet been tested.



No. 2



No. 3



THE LACTOMETER AND FAT TEST FOR CHEESE AND CONDENSED MILK FACTORIES.

Within the last few months some inquiries have been received from parties interested in cheese and condensed milk factories in regard to a test to determine the quality of the milk received at these institutions.

The fat test which very accurately tells the butter value of milk does not give its actual value for making cheese or condensed milk. For instance, a factory may require milk of a certain standard, for instance 3 per cent. fat. Such milk should contain about 9 per cent. solids not fat. A patron may have milk that contains 6 per cent. fat and 10 per cent. other solids. If he should dilute this milk 50 per cent. with water it would then contain 3 per cent. fat and appear by the fat test alone to be up to the standard, while it would be worth but little more than half as much for cheese or condensed milk because it would contain but 5 per cent. solids not fat. Therefore it is necessary to have recourse to some method to detect adulterations besides the fat test, to protect the above institutions and milk buyers in general against fraud. It seems the height of folly for our cheese and condensed milk factories to go on paying for milk by quantity without regard to quality. It is simply putting a premium on dishonesty and poor milk. For who would turn milk from a nice Jersey herd into a factory if he received only the same price per pound as his neighbor who has a herd of ordinary animals yielding milk of much less value.

The most common adulterations are the removing of cream and the addition of water. By determining the fat and the solids not fat, either or both of these adulterations are easily detected.

In many states legal standards for fat and solids not fat have been established in order to protect the public against fraud. In some states the required standard is 3 per cent. fat, others 3.5 per cent. and solids not fat about 9 per cent. Milk from a good sized herd varies but little from day to day. Milk from a single cow may vary quite widely in fat, but from a herd will seldom vary more than 0.2 or 0.3 per cent. and solids not fat even less.

It is rather difficult to fix any standard, so great is the variation in different animals, but it is very rare that the mixed milk from a large herd at any season of the year will fall below 12 per cent. total solids unless it has been diluted. Milk containing less than 9 per cent. solids not fat is suspicious, and a sample containing much less than 8.5 is probably watered. When a standard is adopted the only course to pursue is to consider all milk falling below this standard adulterated. If the milk is not up to the standard it matters not whether it is from poor cows or is diluted after milking, the results are the same.

It is necessary therefore in order to detect adulterations to determine both the fat and the other solids. For the determination of the former we would recommend the Babcock test described in Bulletin No. 3 of this Station and Bulletins Nos. 24 and 31 of Wis. Experiment Station, and then the solids not fat can be quite readily and accurately estimated from the specific gravity and per cent. of fat. The specific gravity of whole milk at 60 F. varies from 1.030 to 1.034. This means that when a certain volume of distilled water at 60 F. weighs just 1000 lbs the same volume of milk will weigh 1.030 to 1.034 lbs. The solids not fat, namely, the casein, albumen, milk, sugar and mineral matter are the constituents of milk that are heavier than water and therefore cause its greater weight. On the other hand the fat is lighter, consequently the abstraction of fat increases the specific gravity, and the addition of water decreases the specific gravity so one can readily tell whether the milk has been skimmed or diluted with water by these two tests. For example suppose a sample of whole milk contains 4.2 per cent. fat, and has a specific gravity of 1.032. If this milk were diluted one half with water it would contain 2.1 per cent. fat and have a specific gravity of about 1.016, while if it were partially skimmed to contain about 2.1 per cent. fat its specific gravity would be increased to about 1.0345.

THE LACTOMETER.

The instrument we would recommend for taking the specific gravity is the lactometer, which is sufficiently accurate for practical purposes. There are several kinds in use at the present time, all of which are made on the same general principle, viz: A narrow stem attached to an elongated bulb weighted at the bottom so that it will maintain an upright position when floating in the milk, with the stem which is graduated partially submerged.

The mark on the stem to which it sinks shows the specific gravity. The instrument we would recommend for this purpose is the Quevenne lactometer. The scale on the stem expresses in thousands the weight of the liquid in which it is placed as compared with water. The graduations are usually from 15 to 40 degrees. To illustrate, milk having a specific gravity of 1.032 would give a reading of 32 on the Lactometer and one having a specific gravity of 1,025 would give a reading of 25.

Method of Making the Test.

The method of making the fat test has been already described in the bulletins referred to. To take the specific gravity with the lactometer it is necessary, 1st that milk be free from air bubbles, and in order to insure this it should stand at least one half hour after being drawn; 2nd. that it should be thoroughly mixed by pouring carefully from one vessel to another, avoiding any violent motions that would be likely to collect air bubbles, then brought to the proper temperature, 60° F., placed in a vessel of sufficient depth and diameter to allow the lactometer to float freely, and the mark on the stem to which the instrument sinks, read. In case it is not convenient to bring the milk to just the temperature of 60° F., a correction may be made where the variation is not more than 10 degrees, by adding to the lactometer reading 0.1 for each degree the temperature exceeds 60, and subtracting 0.1 for each degree below 60. For example, a lactometer reading of 32 at 65° F., corrected, would read 32.5; at 55° F., corrected, 31.5.

After finding the per cent. of fat, and taking the lactometer reading the per cent. of solids not fat may be found by the table given on the following pages.

Find the per cent. of fat in one of the vertical columns, either to the right or left of the table and the lactometer reading at the top of the table in the line of figures marked lactometer reading, then look down the column of figures directly under the lactometer reading till on line with the per cent. of fat, and the figures found at this point will be the per cent. of solids not fat in the milk.

For example, suppose the per cent. of fat is 4.5 and the lactometer reading is 32, then the per cent. of solids not fat will be 9.28. The lactometer can easily be read to half degrees when necessary to be quite accurate. Suppose the lactometer reads 31.5 instead of 32 in the above example, then the per cent. of solids not fat would be 9.15. The per cent. of solids not fat added to the per cent. of fat gives total solids.

By means of the methods given, any person of ordinary intelligence and skill, can with a little practice, readily determine the value of milk quite accurately.

After adopting the test, the factory and its patrons must agree upon some method of paying for the milk. There are two or three ways of doing this. One is to adopt a standard, say 3.5 per cent. fat, 9 per cent. other solids and fix a price for milk of this standard. Then pay for milk, testing above or below these figures, more or less in proportion as it tests. Another method is to fix the price per pound for fat and other solids, and determine by the test the number of pounds furnished by each patron. Still another is to fix the price per pound for total solids. Total solids are found by adding the percentage of fat to the percentage of solids found by the table.

Some doubtless will complain that these tests involve too much labor to be practical, but in regard to this we will say, that after one has had some practice, the time required to make the tests is much less than one would suppose. A man can easily test 20 samples in two hours for both fat and other solids. The fat test takes the greater part of the time, and that need not be made more than once a week, especially if the composite sample mentioned in "notes on cream testing" be used.

All lactometer readings must be taken before the milk sours. Quite a number of formulas have been made for estimating solids not fat from the specific gravity and the per cent. of fat, but the table here given is made from one presented by Dr. Babcock, Bulletin No. 31 Wis. Agr. Experiment Station.

The writer has made quite a large number of comparisons in determining solids by this table and by the gravity process, and finds the agreement close enough for practical purposes.

The results can be found on the following pages. The table for solids not fat is so arranged, that it can be taken from the bulletin and mounted on card board for use.

The apparatus for these tests can be obtained from most dealers in dairy supplies. The Quevenne lactometer should always be ordered to use with the table given.

NAME OF COW.	Fat.	Solids not Fat.		NAME OF COW.	Fat.	Solids not Fat.	
		Gravemetric Method.	Babcock Test and Lactometer.			Gravemetric Method.	Babcock Test and Lactometer.
	%	%	%		%	%	%
Nancy......	2.60	8.87	8.87	Agnes	4.30	9.34	9.40
(Ayershire)	3.50	8.80	8.93	(Jersey)	5.50	9.20	9.23
	2.80	8.95	8.75		4.45	9.15	9.41
	3.60	8.89	8.90		5.15	9.25	9.43
	2.70	8.94	8.82		5.00	9.13	9.12
	3.50	8.84	8.90		4.95	9.29	9.37
	2.85	9.07	8.82		4.55	9.17	9.40
	3.50	9.16	8.90		5.30	9 30	9.58
	3.10	8.70	8.85		5.30	9.23	9.34
	2.71	8.63	8.76		4.41	9.13	9.26
	3.40	8.65	8.39		5.00	9.00	9.26
	2.80	8.56	8.60		4.50	9.33	9.15
	3.20	8.43	8.74		5.05	9.22	9.25
	2.70	8.80	8.76		4.55	9.05	9.17
Average ...	....	**8.81**	**8.78**	Average ...	....	**9.20**	**9.31**
Dinsmore ..	4.55	9.45	9.56	L. T.......	4.10	9.27	9.33
(Jersey)	5.80	9.65	9.82	(Jersey)	4.80	9.11	9.32
	5.45	9.90	9.60		4.05	9.23	9.19
	5.40	9.65	9.74		4.75	9.21	9.32
	4.10	9.74	9.60		3.80	9.42	9.26
	5.45	9.69	10.00		4.50	9.36	9.35
	4.50	9.56	9.63		4.20	9.32	9.34
	5.00	9.55	9.78		4.95	9.88	9.52
	6.10	9.49	9.62		4.75	8.92	9.32
	4.42	9.43	9.61		3.83	9.06	9.26
	5.60	9.63	9.65		4.55	9.25	9.28
	4.40	9.63	9.28		3.80	9.20	9.13
	5.15	9.59	9.68		4.65	8.93	9.30
	4.60	9.51	9.56		3.85	9.18	9.26
Average ...	....	**9.61**	**9.65**	Average ...	....	**9.24**	**9.23**
Shaw	4.65	9.72	9.56	Herd.......	3.70	9.20	9.11
(Grade)	6.35	9.55	9 34		3.40	8.70	8.78
	4.60	9.86	9.83		3.40	9.40	9.57
	5.65	9.80	9.68		3.20	8.70	9.00
	5.15	9.97	9.69		3.60	9.80	9.61
	6.25	9.70	9.66		4.00	9.60	9.70
	4.80	9.82	9.74	P'r'ly skm'd	1.20	10.40	10.14
	5.60	9.75	9.78	Watered ...	2.00	4.80	4.83
	6.10	9.36	9.62	" ...	2.25	6.70	6.96
	5.00	9.82	9.80	Skimmed ..	0.20	9.32	9.30
	6.00	9.50	9.60				
	5.00	9.72	9.65				
	5.60	9.44	9.55				
	5.20	9.55	9.43				
Average ...	....	**9.68**	**9.64**				

Table showing per cent. of solids not fat corresponding to per cent. of fat and Quevenne lactometer reading.

Per cent. of Fat.	LACTOMETER READING.																								Per cent. of Fat.
	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	
0.1	4.44	4.70	4.96	5.22	5.48	5.74	6.00	6.26	6.52	6.78	7.04	7.30	7.56	7.82	8.08	8.34	8.60	8.86	9.12	9.38	9.64	9.90	10.16	10.42	0.1
0.2	4.46	4.72	4.98	5.24	5.50	5.76	6.02	6.28	6.54	6.80	7.06	7.32	7.58	7.84	8.10	8.36	8.62	8.88	9.14	9.40	9.66	9.92	10.18	10.44	0.2
0.3	4.48	4.74	5.00	5.26	5.52	5.78	6.04	6.30	6.56	6.82	7.08	7.34	7.60	7.86	8.12	8.38	8.64	8.90	9.16	9.42	9.68	9.94	10.20	10.46	0.3
0.4	4.50	4.76	5.02	5.28	5.54	5.80	6.06	6.32	6.58	6.84	7.10	7.36	7.62	7.88	8.14	8.40	8.66	8.92	9.18	9.44	9.70	9.97	10.23	10.49	0.4
0.5	4.52	4.78	5.04	5.30	5.56	5.82	6.08	6.34	6.60	6.86	7.12	7.38	7.64	7.90	8.16	8.42	8.68	8.95	9.21	9.47	9.73	9.99	10.25	10.51	0.5
0.6	4.54	4.80	5.06	5.32	5.58	5.84	6.10	6.36	6.62	6.88	7.14	7.40	7.66	7.93	8.19	8.45	8.71	8.97	9.23	9.49	9.75	10.01	10.27	10.53	0.6
0.7	4.56	4.82	5.08	5.34	5.60	5.86	6.12	6.38	6.64	6.91	7.17	7.43	7.69	7.95	8.21	8.47	8.73	8.99	9.25	9.51	9.77	10.03	10.29	10.55	0.7
0.8	4.58	4.84	5.10	5.36	5.62	5.88	6.14	6.40	6.67	6.93	7.19	7.45	7.71	7.97	8.23	8.49	8.75	9.01	9.27	9.53	9.79	10.05	10.31	10.57	0.8
0.9	4.60	4.86	5.12	5.38	5.64	5.90	6.17	6.43	6.69	6.95	7.21	7.47	7.73	7.99	8.25	8.51	8.77	9.03	9.29	9.55	9.81	10.07	10.33	10.59	0.9
1.0	4.62	4.88	5.14	5.40	5.66	5.93	6.19	6.45	6.71	6.97	7.23	7.49	7.75	8.01	8.27	8.53	8.79	9.05	9.31	9.57	9.83	10.09	10.35	10.61	1.0
1.1	4.64	4.90	5.17	5.43	5.69	5.95	6.21	6.47	6.73	6.99	7.25	7.51	7.77	8.03	8.29	8.55	8.81	9.07	9.33	9.59	9.85	10.12	10.38	10.64	1.1
1.2	4.66	4.92	5.19	5.45	5.71	5.97	6.23	6.49	6.75	7.01	7.27	7.53	7.79	8.05	8.31	8.57	8.83	9.09	9.35	9.62	9.88	10.14	10.40	10.66	1.2
1.3	4.68	4.95	5.21	5.47	5.73	5.99	6.25	6.51	6.77	7.03	7.29	7.55	7.81	8.07	8.33	8.59	8.85	9.12	9.38	9.64	9.90	10.16	10.42	10.68	1.3
1.4	4.70	4.97	5.23	5.49	5.75	6.01	6.27	6.53	6.79	7.05	7.31	7.57	7.83	8.09	8.36	8.62	8.88	9.14	9.40	9.66	9.92	10.18	10.44	10.70	1.4
1.5	4.73	4.99	5.25	5.51	5.77	6.03	6.29	6.55	6.81	7.07	7.33	7.59	7.85	8.12	8.38	8.64	8.90	9.16	9.42	9.68	9.94	10.20	10.46	10.72	1.5
1.6	4.75	5.01	5.27	5.53	5.79	6.05	6.31	6.57	6.83	7.09	6.35	7.61	7.88	8.14	8.40	8.66	8.92	9.18	9.44	9.70	9.96	10.22	10.48	10.75	1.6
1.7	4.77	5.03	5.29	5.55	5.81	6.07	6.33	6.59	6.85	7.11	7.38	7.64	7.90	8.16	8.42	8.68	8.94	9.20	9.46	9.72	9.98	10.25	10.51	10.77	1.7
1.8	4.79	5.05	5.31	5.57	5.83	6.09	6.35	6.61	6.87	7.14	7.40	7.66	7.92	8.18	8.44	8.70	8.96	9.22	9.48	9.75	10.01	10.27	10.53	10.79	1.8
1.9	4.81	5.07	5.33	5.59	5.85	6.11	6.37	6.63	6.90	7.16	7.42	7.68	7.94	8.20	8.46	8.72	8.98	9.24	9.51	9.77	10.03	10.29	10.55	10.81	1.9
2.0	4.83	5.09	5.35	5.61	5.87	6.13	6.39	6.65	6.92	7.18	7.44	7.70	7.96	8.22	8.48	8.74	3.01	9.27	9.53	9.79	10.05	10.31	10.57	10.83	2.0
2.1	4.85	5.11	5.37	5.63	5.89	6.15	6.41	6.68	6.94	7.20	7.46	7.72	7.98	8.24	8.50	8.77	9.03	9.29	9.55	9.81	10.07	10.33	10.59	10.86	2.1
2.2	4.87	5.13	5.39	5.65	5.91	6.17	6.44	6.70	6.96	7.22	7.48	7.74	8.00	8.26	8.53	8.79	9.05	9.31	9.57	9.83	10.09	10.35	10.62	10.88	2.2
2.3	4.89	5.15	5.41	5.67	5.93	6.19	6.46	6.72	6.98	7.24	7.50	7.76	8.02	8.28	8.55	8.81	9.07	9.33	9.59	9.85	10.11	10.38	10.64	10.90	2.3
2.4	4.91	5.17	5.43	5.69	5.95	6.22	6.48	6.74	7.00	7.26	7.52	7.78	8.05	8.31	8.57	8.83	9.09	9.35	9.61	9.87	10.14	10.40	10.66	10.92	2.4
2.5	4.93	5.19	5.45	5.71	5.98	6.24	6.50	6.76	7.02	7.28	7.54	7.81	8.07	8.33	8.59	8.85	9.11	9.37	9.63	9.90	10.16	10.42	10.68	10.94	2.5
2.6	4.95	5.21	5.47	5.73	6.00	6.26	6.52	6.78	7.[illegible]4	7.30	7.56	7.83	8.09	8.35	8.61	8.87	9.13	9.39	9.66	9.92	10.18	10.44	10.70	10.96	2.6
2.7	4.97	5.23	5.49	5.76	6.02	6.28	6.54	6.80	7.06	7.32	7.59	7.85	8.11	8.37	8.63	8.89	9.16	9.42	9.68	9.94	10.20	10.46	10.72	10.99	2.7
2.8	4.99	5.25	5.51	5.78	6.04	6.30	6.56	6.82	7.08	7.35	7.61	7.87	8.13	8.39	8.65	8.92	9.18	9.44	9.70	9.96	10.22	10.48	10.75	11.01	2.8
2.9	5.01	5.27	5.54	5.80	6.06	6.32	6.58	6.84	7.10	7.37	7.63	7.89	8.15	8.41	8.67	8.94	9.20	9.46	9.72	9.98	10.24	10.51	10.77	11.03	2.9
3.0	5.03	5.29	5.56	5.82	6.08	6.34	6.60	6.86	7.13	7.39	7.65	7.91	8.17	8.43	8.70	8.96	9.22	9.48	9.74	10.00	10.27	10.53	10.79	11.05	3.0
3.1	5.05	5.31	5.58	5.84	6.10	6.36	6.62	6.88	7.15	7.41	7.67	7.93	8.19	8.46	8.72	8.98	9.24	9.50	9.76	10.03	10.29	10.55	10.81	11.07	3.1
3.2	5.07	5.33	5.60	5.86	6.12	6.38	6.64	6.90	7.17	7.43	7.69	7.95	8.21	8.48	8.74	9.00	9.26	9.52	9.79	10.05	10.31	10.57	10.83	11.09	3.2
3.3	5.09	5.36	5.62	5.88	6.14	6.40	6.66	6.93	7.19	7.45	7.71	7.97	8.24	8.50	8.76	9.02	9.28	9.55	9.81	10.07	10.33	10.59	10.85	11.12	3.3
3.4	5.11	5.38	5.64	5.90	6.16	6.42	6.69	6.95	7.21	7.47	7.73	8.00	8.26	8.52	8.78	9.04	9.30	9.57	9.83	10.09	10.35	10.61	10.88	11.14	3.4
3.5	5.14	5.40	5.66	5.92	6.18	6.44	6.71	6.97	7.23	7.49	7.75	8.02	8.28	8.54	8.80	9.06	9.33	9.59	9.85	10.11	10.37	10.64	10.90	11.16	3.5
3.6	5.16	5.42	5.68	5.94	6.20	6.46	6.73	6.99	7.25	7.5[illegible]	7.78	8.04	8.30	8.56	8.82	9.09	9.35	9.61	9.87	10.13	10.40	10.66	10.92	11.18	3.6
3.7	5.18	5.44	5.70	5.96	6.22	6.49	6.75	7.01	7.27	7.53	7.80	8.06	8.32	8.58	8.84	9.11	9.37	9.63	9.89	10.16	10.42	10.68	10.94	11.20	3.7
3.8	5.20	5.46	5.72	5.98	6.24	6.51	6.77	7.03	7.29	7.56	7.82	8.08	8.34	8.60	8.87	9.13	9.39	9.65	9.91	10.18	10.44	10.70	10.96	11.23	3.8
3.9	5.22	5.48	5.74	6.00	6.27	6.53	6.79	7.05	7.31	7.58	7.84	8.10	8.36	8.63	8.89	9.15	9.41	9.67	9.94	10.20	10.46	10.72	10.99	11.25	3.9
4.0	5.24	5.50	5.76	6.02	6.29	6.55	6.81	7.07	7.34	7.60	7.86	8.12	8.38	8.65	8.91	9.17	9.43	9.70	9.96	10.22	10.48	10.75	11.01	11.27	4.0
4.1	5.26	5.52	5.7[illegible]	6.04	6.31	6.57	6.83	7.09	7.36	7.62	7.88	8.14	8.41	8.67	8.93	9.19	9.46	9.72	9.98	10.24	10.50	10.77	11.03	11.29	4.1
4.2	5.28	5.54	5.80	6.07	6.33	6.59	6.85	7.12	7.38	7.64	7.90	8.16	8.43	8.69	8.95	9.21	9.48	9.74	10.00	10.26	10.53	10.79	11.05	11.31	4.2
4.3	5.30	5.56	5.82	6.09	6.35	6.61	6.87	7.14	7.40	7.66	7.92	8.19	8.45	8.71	8.97	9.24	9.50	9.76	10.02	10.29	10.55	10.81	11.07	11.34	4.3
4.4	5.32	5.58	5.84	6.11	6.37	6.63	6.89	7.16	7.42	7.68	7.94	8.21	8.47	8.73	8.99	9.26	9.52	9.78	10.04	10.31	10.57	10.83	11.09	11.36	4.4
4.5	5.34	5.60	5.86	6.13	6.39	6.65	6.92	7.18	7.44	7.70	7.97	8.23	8.49	8.75	9.02	9.28	9.54	9.80	10.07	10.33	10.59	10.85	11.12	11.38	4.5
4.6	5.36	5.62	5.89	6.15	6.41	6.67	6.94	7.20	7.46	7.73	7.99	8.25	8.51	8.77	9.04	9.30	9.56	9.83	10.09	16.35	10.61	10.88	11.14	11.40	4.6
4.7	5.38	5.64	5.91	6.17	6.43	6.69	6.96	7.22	7.48	7.75	8.01	8.27	8.53	8.80	9.06	9.32	9.58	9.85	10.11	10.37	10.64	10.90	11.16	11.42	4.7
4.8	5.40	5.66	5.93	6.19	6.45	6.72	6.98	7.24	7.50	7.77	8.03	8.29	8.55	8.82	9.08	9.34	9.61	9.87	10.[illegible]3	10.39	10.66	10.92	11.18	11.45	4.8
4.9	5.42	5.69	5.95	6.21	6.47	6.74	7.00	7.26	7.53	7.79	8.05	8.31	8.58	8.84	9.10	9.37	9.63	9.89	10.15	10.42	10.68	10.94	11.20	11.47	4.9
5.0	5.44	5.71	5.97	6.23	6.49	6.76	7.02	7.28	7.55	7.81	8.07	8.33	8.60	8.86	9.12	9.39	9.65	9.91	10.17	10.44	10.70	10.96	11.23	11.49	5.0
5.1	5.46	5.73	5.99	6.25	6.52	6.78	7.04	7.30	7.57	7.83	8.09	8.36	8.62	8.88	9.15	9.41	9.67	9.93	10.20	10.46	10.72	10.99	11.25	11.51	5.1
5.2	5.48	5.75	6.01	6.27	6.54	6.80	7.06	7.33	7.59	7.85	8.11	8.38	8.64	8.90	9.17	9.43	9.69	9.96	10.22	10.48	10.74	11.01	11.27	11.53	5.2
5.3	5.51	5.77	6.03	6.29	6.56	6.82	7.08	7.35	7.61	7.87	8.14	8.40	8.66	8.92	9.19	9.45	9.71	9.98	10.24	10.50	10.77	11.03	11.29	11.55	5.3
5.4	5.53	5.79	6.05	6.31	6.58	6.84	7.10	7.37	7.63	7.89	8.16	8.42	8.68	8.95	9.21	9.47	9.74	10.00	10.26	10.52	10.79	11.05	11.31	11.58	5.4
5.5	5.55	5.81	6.07	6.34	6.60	6.86	7.13	7.39	7.65	7.92	8.18	8.44	8.70	8.97	9.23	9.49	9.76	10.02	10.28	10.55	10.81	11.07	11.34	11.60	5.5
5.6	5.57	5.83	6.09	6.36	6.62	6.88	7.15	7.41	7.67	7.94	8.20	8.46	8.73	8.99	9.25	9.52	9.78	10.04	10.31	10.57	10.83	11.10	11.36	11.62	5.6
5.7	5.59	5.85	6.11	6.38	6.64	6.90	7.17	7.43	7.69	7.96	8.22	8.48	8.75	9.01	9.27	9.54	9.80	10.06	10.33	10.59	10.85	11.12	11.38	11.64	5.7
5.8	5.61	5.87	6.13	6.40	6.66	6.92	7.19	7.45	7.72	7.98	8.24	8.50	8.77	9.03	9.30	9.56	9.82	10.09	10.35	10.[illegible]1	10.88	11.14	11.40	11.67	5.8
5.9	5.63	5.89	6.16	6.42	6.68	6.95	7.21	7.47	7.74	8.00	8.26	8.53	8.79	9.05	9.32	9.58	9.84	10.11	10.37	10.63	10.90	11.16	11.42	11.69	5.9
6.0	5.65	5.91	6.18	6.44	6.70	6.97	7.23	7.49	7.76	8.02	8.28	8.55	8.81	9.07	9.34	9.60	9.87	10.13	0.39	10.66	10.92	11.18	11.45	11.71	6.0
	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	

No. 5